ETH zürich

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# Übung 1
# Logische Verknüpfungen

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# Über mich

- Josephine Loehle (jloehle@student.ethz.ch)
- Elektrotechnik 3. Semester
- Hobbies: Geige, Klavier, Tennis, Japanisch

- Vorstellungsrunde?

# Ablauf einer typischen Übungsstunde

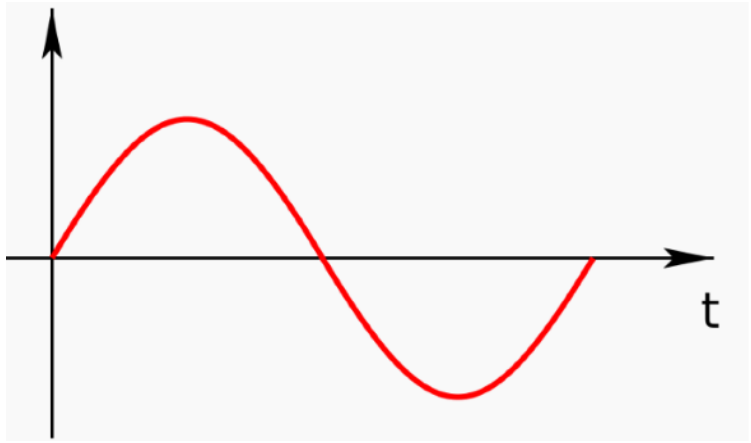
- Theorie
- Beispielaufgabe/Quiz
- Vor-/Nachbesprechung der Serien
- Zeit zum Serien lösen und Fragen stellen

- Bonus: 7 Serien + 2 Prüfungen
- Abgabe Serien in Übungsstunde oder per Mail (jloehle@student.ethz.ch)
- Slides auf Website (https://www.n.ethz.ch/student/jloehle/)

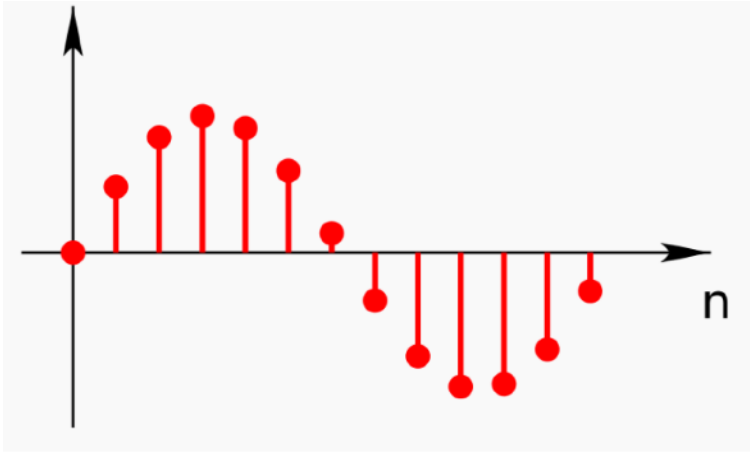
# Theorie

# Analog vs. Digital

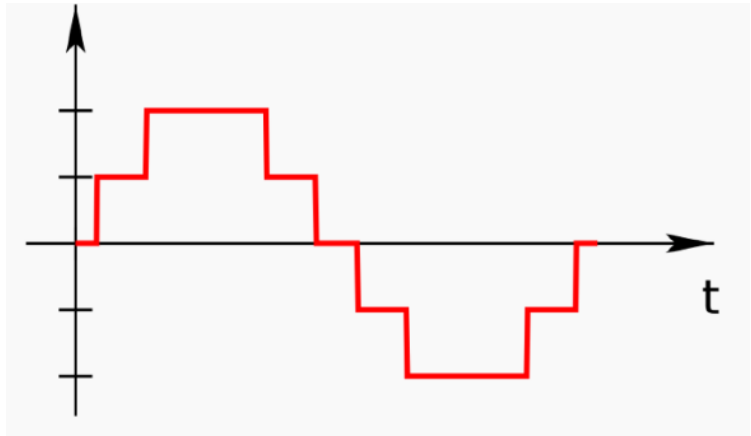
- Kontinuierlich = unendlich…
- Diskret = abzählbar…



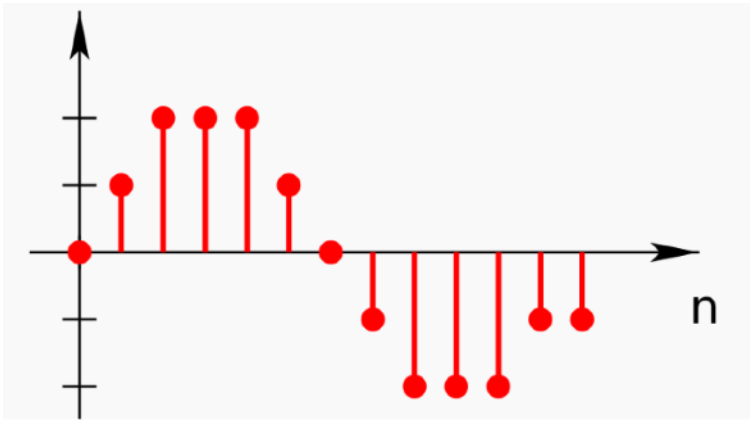

Analog




Zeitdiskret




Wertediskret

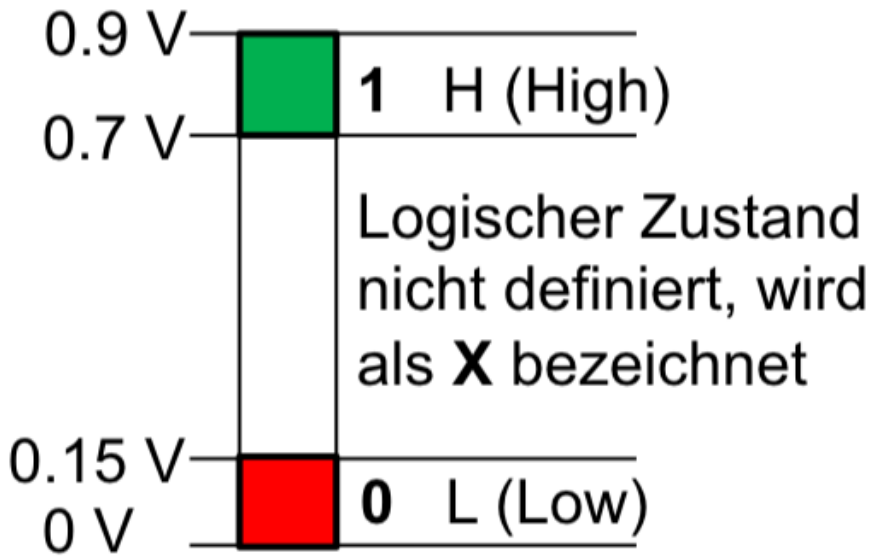


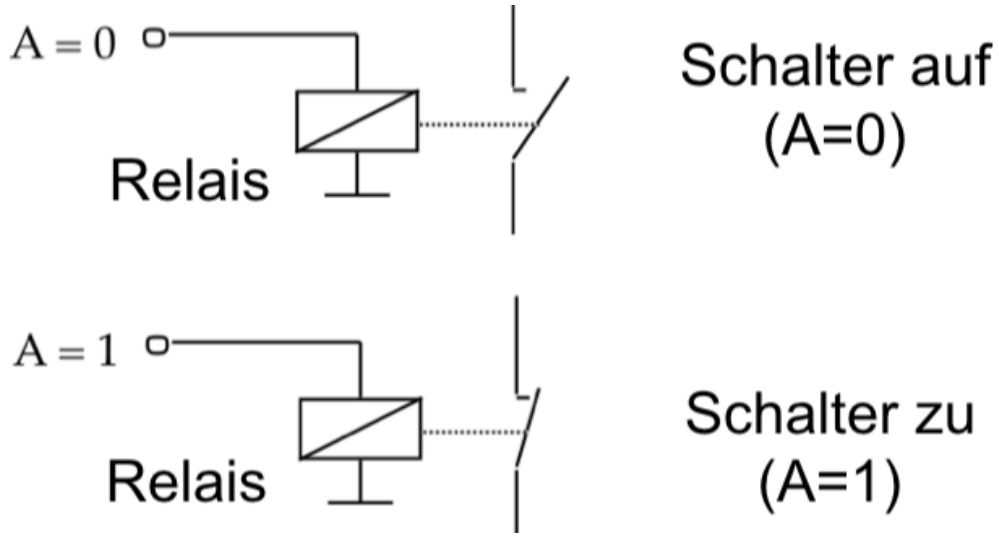

Digital

# Zweiwertige Logik – Bits

## Bits

- 2 binäre Zustände: 0 & 1
- n Bits können 2^n Zustände beschreiben
- MSB … LSB



# Wahrheitstabellen

- N Eingänge
- M Ausgänge

2^N Zeilen

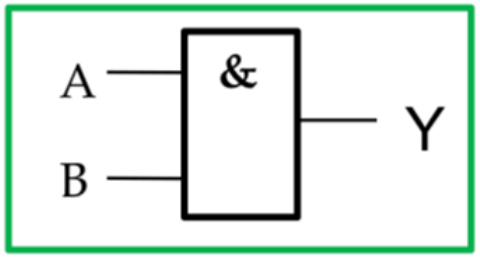
| A | B | C | Y |
|---|---|---|---|
| 0 | 0 | 0 | $f(0,0,0) \in \{0,1\}$ |
| 0 | 0 | 1 | $f(0,0,1) \in \{0,1\}$ |
| 0 | 1 | 0 | $f(0,1,0) \in \{0,1\}$ |
| 0 | 1 | 1 | $f(0,1,1) \in \{0,1\}$ |
| 1 | 0 | 0 | $f(1,0,0) \in \{0,1\}$ |
| 1 | 0 | 1 | $f(1,0,1) \in \{0,1\}$ |
| 1 | 1 | 0 | $f(1,1,0) \in \{0,1\}$ |
| 1 | 1 | 1 | $f(1,1,1) \in \{0,1\}$ |

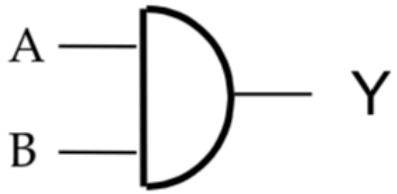
M + N Spalten

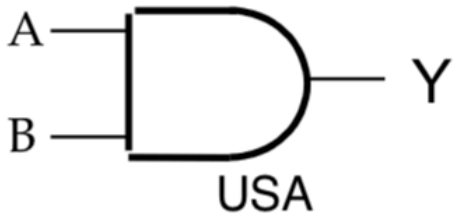
# UND-Verknüpfung

- Y = 1, wenn A = 1 & B = 1

Hier verwendet




| A | B | Y |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

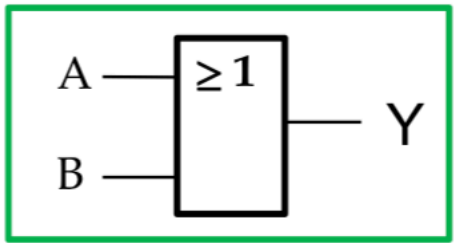
$$Y = A \wedge B \qquad Y = A \cdot B$$

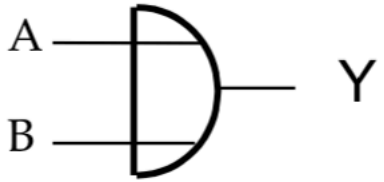
Hier verwendet

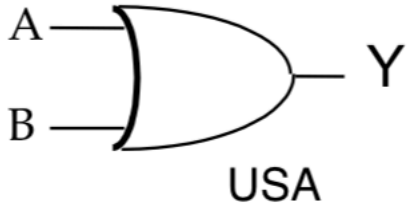
# ODER-Verknüpfung

- Y = 1, wenn A = 1 &/oder B = 1

Hier verwendet



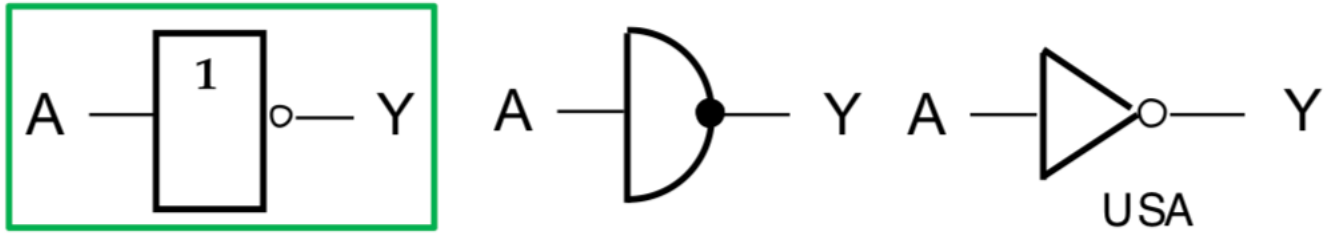




| A | B | Y |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |

$$Y = A \vee B \qquad Y = A + B$$

# INVERTER

- Y = 1, wenn A = 0

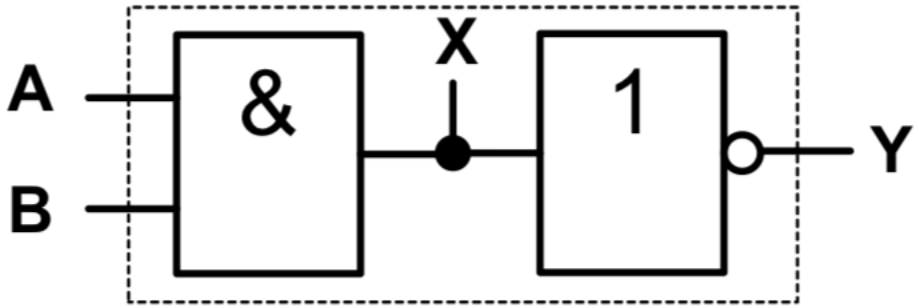


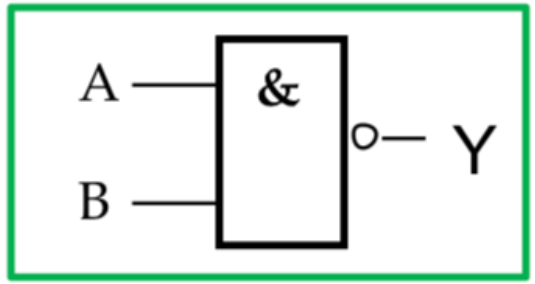

| A | Y |
|---|---|
| 0 | 1 |
| 1 | 0 |

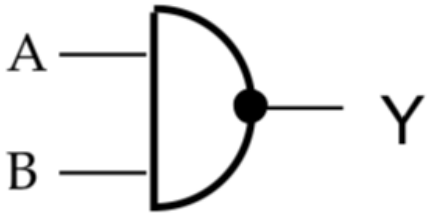
Hier verwendet $Y = \overline{A}$

# NAND-Gatter

- Y = 1, wenn A = 0 &/oder B = 0



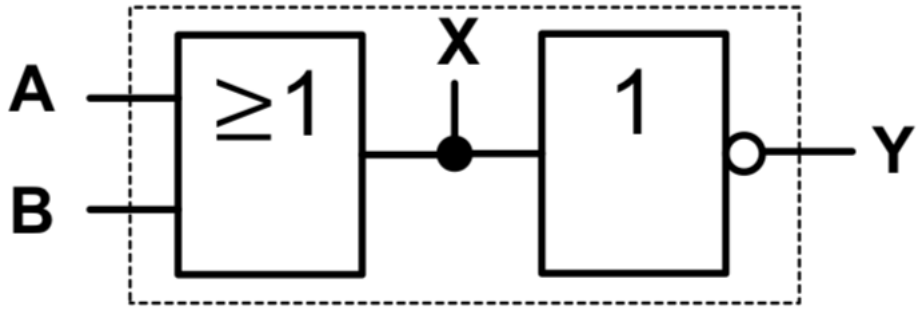

| A | B | X | Y |
|---|---|---|---|
| 0 | 0 | 0 | 1 |
| 0 | 1 | 0 | 1 |
| 1 | 0 | 0 | 1 |
| 1 | 1 | 1 | 0 |

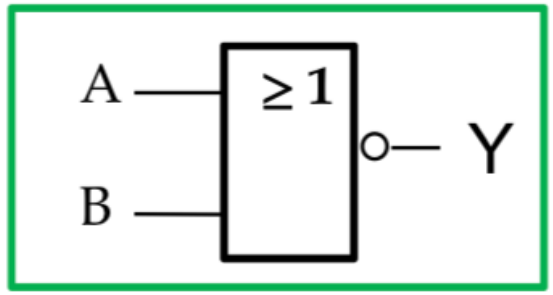
$$Y = \overline{A \wedge B} \qquad Y = \overline{A \cdot B}$$

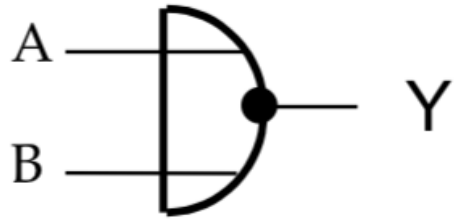
Hier verwendet

# NOR-Gatter

- Y = 1, wenn A = 0 & B = 0




| A | B | X | Y |
|---|---|---|---|
| 0 | 0 | 0 | 1 |
| 0 | 1 | 1 | 0 |
| 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 |

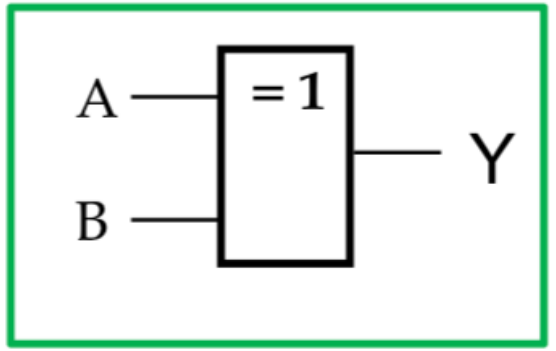
$$Y = \overline{A \vee B} \qquad Y = \overline{A + B}$$

# XOR-Gatter

- Y = 1, wenn A = 0 oder B = 0

| A | B | X | Y |
|---|---|---|---|
| 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 1 |
| 1 | 0 | 0 | 1 |
| 1 | 1 | 1 | 0 |

Hier verwendet



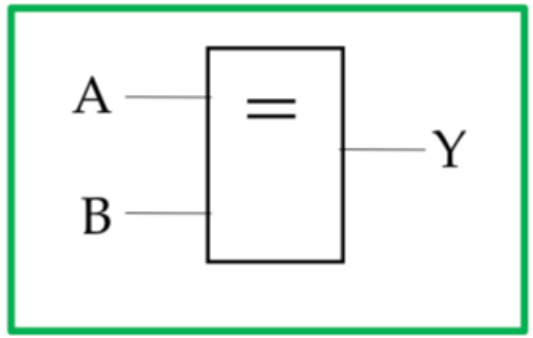

Hier verwendet

$$Y = A \oplus B$$

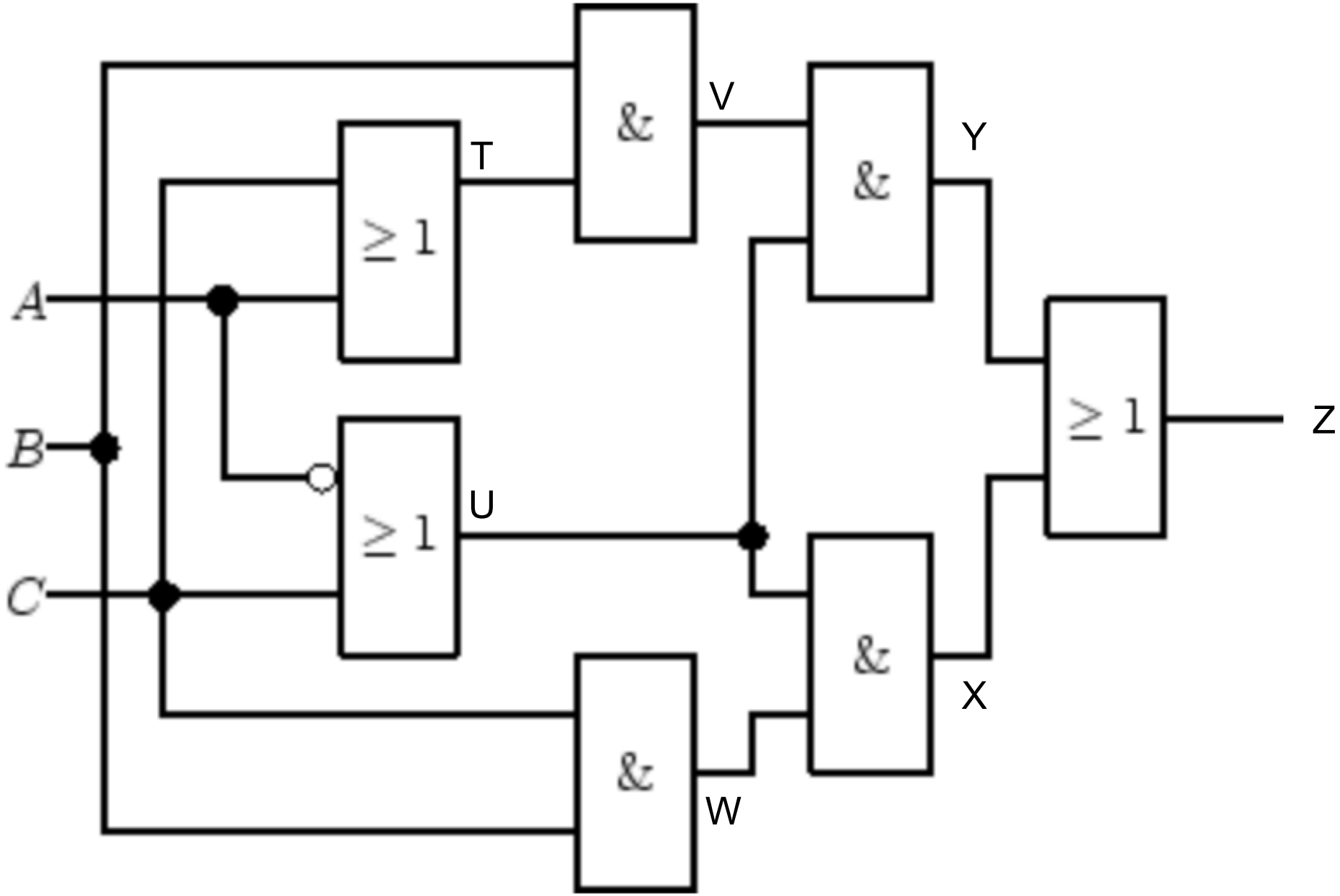
# XNOR-Gatter

- Invertiertes XOR-Gatter

$$Y = \overline{A \oplus B}$$



# Aufgabe


A
B
C
≥ 1
≥ 1
T
U
&
V
&
Y
&
X
&
W
≥ 1
Z

| A | B | C | T | U | V | W | X | Y | Z |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

T = A + C  U = !A + C  V = B * T  W = B * C  X = U * W  Y = U * V  Z = X + Y

https://www.n.ethz.ch/student/jloehle/